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10/656,710	09/05/2003	William H. Mook JR.	WHM 2-087	8277

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EXAMINER	
DIAMOND, ALAN D	

ART UNIT	PAPER NUMBER
1753	

DATE MAILED: 04/11/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/656,710	MOOK, WILLIAM H.	
	Examiner	Art Unit	
	Alan Diamond	1753	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 January 2004*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-59* is/are pending in the application.

4a) Of the above claim(s) *48-59* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-47* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *05 September 2003* is/are: a)☐ accepted or b)☒ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

1. Applicant's election with traverse of Group I, claims 1-47 in the reply filed on January 24, 2005 is acknowledged. The traversal is on the ground(s) that Section 121 of the Patent Statute authorized a requirement for a restriction only when two or more independent and distinct inventions are claimed in one application, and that the instant inventions are dependent in that each is related to the other in operation and effect. This is not found persuasive because the meaning of "Independent" and "Distinct" is set forth in MPEP 802.01. According to MPEP 803 restriction is proper when the inventions are distinct and there is a serious burden on the examiner. In the instant case, the inventions are distinct, each from the other because of the following reasons: Inventions Group II and Group I are related as product and process of use. The inventions can be shown to be distinct if either or both of the following can be shown: (1) the process for using the product as claimed can be practiced with another materially different product or (2) the product as claimed can be used in a materially different process of using that product (MPEP § 806.05(h)). In the instant case, the product as claimed can be used in a materially different process of using that product, such as one where no components of solar energy are removed, but rather the solar energy impinges directly on the photovoltaic cells. Furthermore, the product as claimed can be used in a materially different process of using that product, such as in a thermophotovoltaic process where, instead of using solar radiation, the radiation emitted from a ceramic thermophotovoltaic emitter is used as the radiation source.

Furthermore, the product as claimed can be used in a materially different process of using that product, such as one wherein, instead of using solar radiation, alpha or beta radiation is used as the radiation source. Alternatively, the process for using the product as claimed can be practiced with another materially different product, such as photovoltaic cells that are parallel connected instead of series connected.

Furthermore, there is serious burden on the Examiner for the following two reasons: 1) Because these inventions are distinct for the reasons given above and the search required for Group I is not required for Group II, restriction for examination purposes as indicated is proper; and 2) Because these inventions are distinct for the reasons given above and the search required for Group II is not required for Group I, restriction for examination purposes as indicated is proper

The requirement is still deemed proper and is therefore made FINAL.

2. Claims 48-59 are withdrawn from further consideration pursuant to 37 CFR 1.142(b), as being drawn to a nonelected invention, there being no allowable generic or linking claim. Applicant timely traversed the restriction (election) requirement in the reply filed on January 24, 2005.

Drawings

3. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "136" in Figure 8 has been used to designate both an arrow and a concentrator block. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures

appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

4. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(4) because reference character "180" has been used to designate both an A.C. Storage Systems block in Figure 8 and a mirror in Figure 10. Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

5. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they include the following reference character(s) not mentioned in the description: reference sign 240 in Figure 11; and reference sign 532 in Figure 19. Corrected drawing sheets in compliance with 37 CFR 1.121(d), or amendment to the specification to add the reference character(s) in the description in compliance with 37

CFR 1.121(b) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

6. The drawings are objected to as failing to comply with 37 CFR 1.84(p)(5) because they do not include the following reference sign(s) mentioned in the description: reference sign 78 (see page 11, line 15); reference sign 132 (see page 12, line 28); reference sign 170 (see page 13, line 22); and reference sign 200 (see page 14, line 11). Corrected drawing sheets in compliance with 37 CFR 1.121(d) are required in reply to the Office action to avoid abandonment of the application. Any amended replacement drawing sheet should include all of the figures appearing on the immediate prior version of the sheet, even if only one figure is being amended. Each drawing sheet submitted after the filing date of an application must be labeled in the top margin as either "Replacement Sheet" or "New Sheet" pursuant to 37 CFR 1.121(d). If the changes are not accepted by the examiner, the applicant will be notified and informed of any required corrective action in the next Office action. The objection to the drawings will not be held in abeyance.

Specification

7. The disclosure is objected to because of the following informalities: On page 10, at line 16, the language "the which will" needs to be corrected. On page 20, at line 12, the term "Fig. 28" should be changed to "Fig. 20". In the amendment to the specification filed January 24, 2005, and in particular, in the amendment to the paragraph that begins on page 10, at line 21, in the line after Planck's formula, the bar should be above the "h" that follows the word "where" rather than above the "w" in the word "where". Appropriate correction is required.

Double Patenting

8. Applicant is advised that should claim 5 be found allowable, claim 10 will be objected to under 37 CFR 1.75 as being a substantial duplicate thereof. When two claims in an application are duplicates or else are so close in content that they both cover the same thing, despite a slight difference in wording, it is proper after allowing one claim to object to the other as being a substantial duplicate of the allowed claim. See MPEP § 706.03(k).

Claim Rejections - 35 USC § 112

9. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

10. Claims 1-47 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In claim 1, at lines 12-13, the term "substantially ineffective" is indefinite because it is subjective. The same applies to dependent claims 2-21. It is suggested that "substantially" be deleted from said term.

In claim 2, at line 2, it is not clear what is meant by the term "as have a" it is suggested that said term be changed to "has a". The same applies to dependent claim 3.

In claim 7, at line 3, the term "substantially uniform" is indefinite because it is subjective. The same applies to dependent claims 8 and 9. It is suggested that "substantially" be deleted from said term.

In claim 21, at line 3, it is not clear what is meant by a "diachronic component" in relation to the rest of the claim. The term "diachronic" has nothing to do with light or mirrors. It is suggested that said term be changed to "dichroic".

In claim 17, at line 6, the term "substantially uniform" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 17, at line 7, the term "substantially flat" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 19 at line 13, and in claim 20 at line 13, the term "substantially extending" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 21, at line 4, the term "substantially ineffective" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claims 22, at lines 11-12, the term "substantially ineffective" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term. The same applies to dependent claims 23-47.

In claim 29, at line 3, the term "substantially uniform" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 39, at line 6, the term "substantially uniform" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 39, at line 7, the term "substantially flat" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term.

In claim 40, at line 7, the term "substantial match" is indefinite because it is subjective. It is suggested that "substantially" be deleted from said term. The same applies to dependent claims 41-45.

Claim Rejections - 35 USC § 102

11. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

12. Claims 1, 2, 4-7, 10, 21, 22, 24, 25, 27-30, 46, and 47 are rejected under 35 U.S.C. 102(b) as being anticipated by House et al, U.S. Patent 4,082,570.

With respect to step (a) in instant claim 1, House et al provides the instant multijunction photovoltaic cell having a series connected array of junction unit cells (referred to as semiconductor diodes (10) by House et al) with a stack orientation, a

multijunction defined edge illumination receiving surface, the instant impurity doped photovoltaic material, and terminals (see Figure 1 col. 4, lines 20-61). With respect to step (a) in instant claims 22 and 24, House et al's series connected array of semiconductor diodes (10) correspond to the instant series-connected array of photovoltaic cells since each diode (10) is a unit cell of the array (see Figure 1; col. 2, lines 32-44; and col. 4, lines 21-32). The photovoltaic cell can be made from, for example, doped silicon, which inherently has a given bandgap energy at a bandgap energy wavelength, as per step (a) in instant claims 1 and 22 (see col. 11, lines 42-63). With respect to step (b) in said claims 1 and 22, incoming solar radiation (28) is concentrated by plano-convex lens (28) within a light concentration path (see Figure 1; and col. 4, lines 38-45). The transmission characteristics of the lens (28) are controlled so that it acts as a bandpass filter for wavelengths in the range of about 5000 to 10,000 Angstroms (see the paragraph bridging cols. 10 and 11). It is the Examiner's position that components of the solar energy that are ineffective to evoke cell electrical output are removed, as per instant step (c) in said claims 1 and 22, and corrected light is produced, particularly in view of House et al's teaching that silicon does not respond to wavelengths greater than about 10,000 Angstroms (see col. 8, lines 20-26). Furthermore, said lens (28) directs the corrected light to the cell edge illumination surface as in instant step (d) of said claims 1 and 22 (see Figure 1; and col. 4, lines 38-45). As seen in Figure 1, there are terminals (16) at either end of the photovoltaic cell to be connected to a load, as per step (e) in instant claim 1 (see col. 4, lines 46-61).

With respect to claims 2 and 25, the stack orientation in House et al can be at an

angle less than 90°, e.g. an angle of about 70° (i.e. House et al's deviation angle of about 20° from parallel) with respect to the receiving surface (see Figures 1 and 3E; and the paragraph bridging cols. 6 and 7).

With respect to claims 4, 6, 21, and 27 the concentrating lens (28) is dichroic since the light is divided into two parts, i.e. the wavelengths in the range from about 5000 to about 10,000 Angstroms which are transmitted to the photovoltaic cell, and the wavelengths above about 10,000 Angstroms and below about 5000 Angstroms which are reflected (see col. 8, lines 15-26; and the paragraph bridging col. 10 and 11). The concentrating lens (28) is a mirror due to the fact that it reflects said wavelengths above about 10,000 Angstroms and below about 5000 Angstroms. The reflected wavelengths above about 10,000 Angstroms correspond to wavelengths above the bandgap energy wavelength (e.g., of silicon) which actually has a bandgap energy wavelength of 11,000 Angstroms, i.e., 1100 nm. The wavelengths below about 5000 Angstrom correspond to wavelengths below the bandgap energy wavelength (e.g., of silicon) (see also col. 8, lines 20-22). The wavelengths above about 10,000 Angstrom are ineffective to evoke cell electrical output (see col. 8, lines 20-22).

With respect to claims 5, 10, and 28, wavelengths in the range of about 5000 to about 10,000 Angstroms are transmitted to the photovoltaic cell (see col. 8, lines 20-22; and the paragraph bridging col. 10 and 11). The about 10,000 Angstroms, i.e., about 1000 nm, corresponds to the bandgap energy wavelength of 1100 nm for silicon, particularly when House et al teaches that silicon does not respond to wavelengths above about 1000 nm (see col. 8, lines 20-22). The about 5000 Angstroms is one-half

of this.

With respect to claims 7, 29, and 30, it is the Examiner's position that House et al's lens (28) provides for the instant substantially uniform integrity of the impinging light, and homogenizes the light prior to impingement upon the receiving surface of the photovoltaic cell.

With respect to claims 46 and 47, the lens (28) can contain cyanine dye, which is luminescent (see the paragraph bridging cols. 10 and 11).

Since House et al teaches the limitations of the instant claims, the reference is deemed to be anticipatory.

13. Claims 22, 27, 29-31, 40, 41, and 45 are rejected under 35 U.S.C. 102(b) as being anticipated by Lewis et al, "Multi-Bandgap High Efficiency Converter (Rainbow)", Proceedings of the 32nd Intersociety Energy Conversion Engineering Conference, IECEC-97, Vol. 1, pages 401-406, July 27 to August 1, 1997.

Lewis et al teaches deriving electrical output from solar radiation by providing the series-connected array of photovoltaic cells in Figure 3 at page 404, each cell inherently having an illumination surface, derivable electrical output, a given bandgap energy at a bandgap energy wavelength (for a particular cell type) and a wavelength defined band of useful energy extending below said bandgap energy wavelength (for a particular cell type) (see also the "Bandgap and Efficiency Calculations" section bridging pages 402 and 403); concentrating the solar radiation with a concentration light path with a parabolic Fresnel lens concentrator (see Figure 1 on page 402 which clearly shows that the concentrator is parabolic; and the left col. on page 404 which teaches that the

concentrator is a Fresnel lens); removing components of solar radiation from said concentration light path using, for example plural dichroic beam splitters (filters), with a portion of those wavelengths that are removed being ineffective to evoke cell electrical output (see Figure 1 at page 402; and the "Spectrum Splitter Overview" section at page 404); and, after passing through the beam splitters, impinging on the surface of the solar cells to derive the electrical output (see Figure 1 on page 404).

With respect to claim 27, said dichroic beam splitters split the light so that each solar cell is selectively illuminated with a narrow band of energy, starting for example with 0.205 micron and removing wavelengths greater than the bandgap energy wavelength, and ending at 2.95 microns (see the right column on page 402).

With respect to claims 29 and 30, it is the Examiner's position that said dichroic beam splitters impinge the light on the receiving surface of the solar cells at a substantially uniform intensity, and that said impinging light is homogenized.

With respect to claim 31, in place of the dichroic beam splitters, prisms providing minimal reflective losses can be used (see page 404, right column), and it is the Examiner's position that the prisms would provide the homogenized light impinging on the solar cells.

With respect to claim 40, as seen in Figure 3 at page 404, for each unique solar cell type there is a series-connected array and each solar cell type has a unique bandgap energy wavelength corresponding to a unique wavelength defined band of useful energy (see the paragraph bridging the left and right column on page 403); the dichroic beam splitters remove components of solar energy to match the unique

bandgap energy wavelength and corresponding unique wavelength defined band of useful energy, as here claimed (see pages 402-403); and clearly as seen in said Figure 3, the dichroic beam splitters direct the unique light to the respective solar cells.

With respect to claims 41 and 45, the dichroic beam splitters read on the instant primary concentrator components, and each is a transparent mirror (light passes though as seen in Figure 1), and each has a unique reflective dichroic component that reflects light (as also seen in Figure 1). As seen in said Figure 1, the dichroic beam splitters are mutually spaced and effect a corresponding mutual separation of corrected light paths, as per claim 45.

Since Lewis et al teaches the limitations of the instant claims, the reference is deemed to be anticipatory.

Claim Rejections - 35 USC § 103

14. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

15. Claims 1-7, 10, 21, 22, 24-30, 46, and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over House et al, U.S. Patent 4,082,570.

With respect to step (a) in instant claim 1, House et al provides the instant multijunction photovoltaic cell having a series connected array of junction unit cells (referred to as semiconductor diodes (10) by House et al) with a stack orientation, a multijunction defined edge illumination receiving surface, the instant impurity doped

photovoltaic material, and terminals (see Figure 1 col. 4, lines 20-61). With respect to step (a) in instant claims 22 and 24, House et al's series connected array of semiconductor diodes (10) correspond to the instant series-connected array of photovoltaic cells since each diode (10) is a unit cell of the array (see Figure 1; col. 2, lines 32-44; and col. 4, lines 21-32). The photovoltaic cell can be made from, for example, doped silicon, which inherently has a given bandgap energy at a bandgap energy wavelength, as per step (a) in instant claims 1 and 22 (see col. 11, lines 42-63). With respect to step (b) in said claims 1 and 22, incoming solar radiation (28) is concentrated by plano-convex lens (28) within a light concentration path (see Figure 1; and col. 4, lines 38-45). The transmission characteristics of the lens (28) are controlled so that it acts as a bandpass filter for wavelengths in the range of about 5000 to 10,000 Angstroms (see the paragraph bridging cols. 10 and 11). It is the Examiner's position that components of the solar energy that are ineffective to evoke cell electrical output are removed, as per instant step (c) in said claims 1 and 22, and corrected light is produced, particularly in view of House et al's teaching that silicon does not respond to wavelengths greater than about 10,000 Angstroms (see col. 8, lines 20-26). Furthermore, said lens (28) directs the corrected light to the cell edge illumination surface as in instant step (d) of said claims 1 and 22 (see Figure 1; and col. 4, lines 38-45). As seen in Figure 1, there are terminals (16) at either end of the photovoltaic cell to be connected to a load, as per step (e) in instant claim 1 (see col. 4, lines 46-61).

With respect to claims 2 and 25, the stack orientation in House et al can be at an angle less than 90°, e.g. an angle of about 70° (i.e. House et al's deviation angle of

about 20° from parallel) with respect to the receiving surface (see Figures 1 and 3E; and the paragraph bridging cols. 6 and 7).

With respect to claims 4, 6, 21, and 27 the concentrating lens (28) is dichroic since the light is divided into two parts, i.e. the wavelengths in the range from about 5000 to about 10,000 Angstroms which are transmitted to the photovoltaic cell, and the wavelengths above about 10,000 Angstroms and below about 5000 Angstroms which are reflected (see col. 8, lines 15-26; and the paragraph bridging col. 10 and 11). The concentrating lens (28) is a mirror due to the fact that it reflects said wavelengths above about 10,000 Angstroms and below about 5000 Angstroms. The reflected wavelengths above about 10,000 Angstroms correspond to wavelengths above the bandgap energy wavelength (e.g., of silicon) which actually has a bandgap energy wavelength of 11,000 Angstroms, i.e., 1100 nm. The wavelengths below about 5000 Angstrom correspond to wavelengths below the bandgap energy wavelength (e.g., of silicon) (see also col. 8, lines 20-22). The wavelengths above about 10,000 Angstrom are ineffective to evoke cell electrical output (see col. 8, lines 20-22).

With respect to claims 5, 10, and 28, wavelengths in the range of about 5000 to about 10,000 Angstroms are transmitted to the photovoltaic cell (see col. 8, lines 20-22; and the paragraph bridging col. 10 and 11). The about 10,000 Angstroms, i.e., about 1000 nm, corresponds to the bandgap energy wavelength of 1100 nm for silicon, particularly when House et al teaches that silicon does not respond to wavelengths above about 1000 nm (see col. 8, lines 20-22). The about 5000 Angstroms is one-half of this.

With respect to claims 7, 29, and 30, it is the Examiner's position that House et al's lens (28) provides for the instant substantially uniform integrity of the impinging light, and homogenizes the light prior to impingement upon the receiving surface of the photovoltaic cell.

With respect to claims 46 and 47, the lens (28) can contain cyanine dye, which is luminescent (see the paragraph bridging cols. 10 and 11).

House et al teaches the limitations of the instant claims other than the difference which is discussed below.

With respect to claims 3 and 26, the stack orientation in House et al can be at an angle of about 85° to about 70° (i.e. House et al's deviation angle of about 5° to about 20° from parallel) with respect to the receiving surface (see Figures 1 and 3E; and the paragraph bridging cols. 6 and 7). House et al does not specifically recite an angle generally equivalent to Brewster's angle. However, in the absence of anything unexpected, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have selected an angle within House et al's range of about 70° to about 85°. It is the Examiner's position that an angle generally equivalent to Brewster's angle is within said range of about 70° to about 85°.

16. Claims 22, 27, 29-31, and 40-45 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al, "Multi-Bandgap High Efficiency Converter (Rainbow)", Proceedings of the 32nd Intersociety Energy Conversion Engineering Conference, IECEC-97, Vol. 1, pages 401-406, July 27 to August 1, 1997.

Lewis et al teaches deriving electrical output from solar radiation by providing the series-connected array of photovoltaic cells in Figure 3 at page 404, each cell inherently having an illumination surface, derivable electrical output, a given bandgap energy at a bandgap energy wavelength (for a particular cell type) and a wavelength defined band of useful energy extending below said bandgap energy wavelength (for a particular cell type) (see also the "Bandgap and Efficiency Calculations" section bridging pages 402 and 403); concentrating the solar radiation with a concentration light path with a parabolic Fresnel lens concentrator (see Figure 1 on page 402 which clearly shows that the concentrator is parabolic; and the left col. on page 404 which teaches that the concentrator is a Fresnel lens); removing components of solar radiation from said concentration light path using, for example plural dichroic beam splitters (filters), with a portion of those wavelengths that are removed being ineffective to evoke cell electrical output (see Figure 1 at page 402; and the "Spectrum Splitter Overview" section at page 404); and, after passing through the beam splitters, impinging on the surface of the solar cells to derive the electrical output (see Figure 1 on page 404).

With respect to claim 27, said dichroic beam splitters split the light so that each solar cell is selectively illuminated with a narrow band of energy, starting for example with 0.205 micron and removing wavelengths greater than the bandgap energy wavelength, and ending at 2.95 microns (see the right column on page 402).

With respect to claims 29 and 30, it is the Examiner's position that said dichroic beam splitters impinge the light on the receiving surface of the solar cells at a substantially uniform intensity, and that said impinging light is homogenized.

With respect to claim 31, in place of the dichroic beam splitters, prisms providing minimal reflective losses can be used (see page 404, right column), and it is the Examiner's position that the prisms would provide the homogenized light impinging on the solar cells.

With respect to claim 40, as seen in Figure 3 at page 404, for each unique solar cell type there is a series-connected array and each solar cell type has a unique bandgap energy wavelength corresponding to a unique wavelength defined band of useful energy (see the paragraph bridging the left and right column on page 403); the dichroic beam splitters remove components of solar energy to match the unique bandgap energy wavelength and corresponding unique wavelength defined band of useful energy, as here claimed (see pages 402-403); and clearly as seen in said Figure 3, the dichroic beam splitters direct the unique light to the respective solar cells.

With respect to claims 41 and 45, the dichroic beam splitters read on the instant primary concentrator components, and each is a transparent mirror (light passes though as seen in Figure 1), and each has a unique reflective dichroic component that reflects light (as also seen in Figure 1). As seen in said Figure 1, the dichroic beam splitters are mutually spaced and effect a corresponding mutual separation of corrected light paths, as per claim 45.

Lewis et al teaches the limitations of the instant claims other than the difference which is discussed below.

With respect to claims 42-44, Lewis et al shows that its Fresnel lens concentrator is parabolic (see Figure 1 at page 401 which shows a parabolic concentrator; and the

"Concentrator Optics Issues" section at page 404). Clearly, the lens is transparent. However, the transparent parabolic lens is also a "mirror" as in claim 44 to the extent that the lens will not be perfectly transparent and will reflect some light, albeit a small amount. Indeed, Lewis teaches of concentrator losses for chromatic aberration, lens defects, etc (see page 404, left column). Lewis differs from claims 42-44 in that Lewis et al does not teach providing more than one parabolic Fresnel lens concentrator. However, having multiple of Lewis et al's parabolic Fresnel lens concentrators corresponds to having multiple of Lewis et al's Rainbow systems set side by side, whether or not the systems are connected in series or parallel. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have provided multiple of Lewis et al's Rainbow systems because there is nothing unobvious about providing more than one of what the prior art shows. Furthermore, the use of more than one of Lewis et al's Rainbow systems connected in series or parallel would increase the voltage and/or current output. With respect to claim 43, each parabolic Fresnel lens concentrator, as seen in Figure 1, would have a correspondingly rearwardly disposed set of dichroic beam splitters which are transparent mirrors that both reflect and pass light.

17. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al as applied to claims 22, 27, 29-31, and 40-45 above, and further in view of Swanson, U.S. Patent 4,927,770.

Lewis et al is relied upon for the reasons recited above. As seen in Figure 3, Lewis et al uses a series-connected array of silicon (Si) cells. Lewis et al teaches the

limitations of the instant claim 23, the difference being that Lewis et al does not specifically teach that its Si solar cells are back surface point contact solar cells. Swanson teaches a back surface point contact Si solar cell that provides the advantage of an efficiency up to 30% (see col. 2, lines 3-41). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Swanson's back surface point contact Si solar cell for the Si solar cell in Lewis et al's series-connected array of silicon (Si) cells because Swanson's back surface point contact Si solar cell provides the advantage of an efficiency up to 30%, as taught by Swanson.

18. Claims 32-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al as applied to claims 22, 27, 29-31, and 40-45 above, and further in view of Penn (U.S. Patent 6,469,241), Clark (U.S. Patent 4,350,837), and Winston (U.S. Patent 3,923,381).

Lewis et al is relied upon for the reasons recited above. Lewis et al teaches the use of aluminum mirrors (see the right paragraph on page 405), but with respect to claims 32-34, does not specifically teach that the mirror is a primary concentrator, nor does Lewis et al teach the instant non-imaging concentrator. Penn and Clark are relied upon for showing the use of a mirror as a primary concentrator for a solar cell system (see Figure 3 of Penn; and Figure 2 of Clark). In particular, Penn shows receiving mirror (30) to concentrate the light (see Figure 3 and col. 8, lines 27-29), and Clark shows concentrator, i.e:, mirror (1) (see Figure 2; and col. 4, lines 28-47). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Lewis et al's aluminum mirrors as primary concentrators in Lewis et al's

device because mirrors are conventionally used as primary concentrators in solar cell devices, as shown by Penn and Clark, and so as to concentrate the light.

Furthermore, Winston teaches the instant non-imaging concentrator having the instant inwardly depending logarithmically defined sloping surface having an angle with respect to a centrally disposed axis, as here claimed (see Figures 3, 7, 12-14, and 16; and col. 5, line 57 through col. 8, line 33). As seen in Figure 16, the concentrator is directly above the solar energy collection device. Winston's non-imaging concentrator provides the advantage of exceptional efficiency for the collection and concentration of electromagnetic energy (see col. 2, lines 23-25). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have provided Lewis et al's device with the concentrator's of Winston directly above the solar cells, i.e., between the solar cells and the dichroic beam splitters, because Winston teaches the use of its non-imaging concentrator directly above the energy collector, and Winston's non-imaging concentrator provides the advantage of exceptional efficiency for the collection and concentration of electromagnetic energy.

19. Claim 38 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al as applied to claims 22, 27, 29-31, and 40-45 above, and further in view of Bell, U.S. Patent 4,115,149.

Lewis et al, as relied upon for the reasons recited above, teaches the limitations of instant claim 38, the difference being that Lewis et al does not specifically teach, for example, the use of a spherical mirror as a coma of light distribution in place of its parabolic Fresnel lens. Bell teaches the alternative use of a Fresnel lens or a spherical

mirror with natural spherical aberrations to reduce the inefficiency of a photovoltaic cell-concentrator arrangement (see abstract; col. 2, lines 26-37; and col. 4, lines 15-28). It is the Examiner's position that said natural spherical aberrations lead to the instant coma of light distribution. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Bell's spherical mirror in place of Lewis et al's Fresnel lens because Bell teaches the alternative use of a spherical mirror with natural spherical aberrations to provide the advantage of reducing the inefficiency of a photovoltaic cell-concentrator arrangement.

20. Claims 1-8, 10, 18-21, 24-26, 28, 46, and 47 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al as applied to claims 22, 27, 29-31, and 40-45 above, and further in view of House et al, U.S. Patent 4,082,570.

Lewis et al, as relied upon for the reasons recited above, teaches the limitation of claims 1-8, 10-21, 24-26, 28, 46, and 47, the main difference being that Lewis et al does not specifically teach that its solar cells can be a series connected stacked array of junction cells with a stack orientation and the receiving surface is a multijunction defined illumination receiving surface. There are other differences with some of dependent claims 2-7, 10, 21, 25, 25, 28, 46, and 47, but the features in these dependent claims are taught by House et al, as set forth below. Furthermore, it should be noted that with respect to instant claim 8, in place of the dichroic beam splitters, Lewis et al teaches prisms providing minimal reflective losses can be used (see page 404, right column), and it is the Examiner's position that the prisms would provide the light of uniform energy level impinging on the solar cells.

With respect to step (a) in instant claim 1, House et al provides the instant multijunction photovoltaic cell having a series connected array of junction unit cells (referred to as semiconductor diodes (10) by House et al) with a stack orientation, a multijunction defined edge illumination receiving surface, the instant impurity doped photovoltaic material, and terminals (see Figure 1 col. 4, lines 20-61). With respect to step (a) in instant claims 22 and 24, House et al's series connected array of semiconductor diodes (10) correspond to the instant series-connected array of photovoltaic cells since each diode (10) is a unit cell of the array (see Figure 1; col. 2, lines 32-44; and col. 4, lines 21-32). The photovoltaic cell can be made from, for example, doped silicon, which inherently has a given bandgap energy at a bandgap energy wavelength, as per step (a) in instant claim 1 (see col. 11, lines 42-63). With respect to step (b) in said claim 1, incoming solar radiation (28) is concentrated by plano-convex lens (28) within a light concentration path (see Figure 1; and col. 4, lines 38-45). The transmission characteristics of the lens (28) are controlled so that it acts as a bandpass filter for wavelengths in the range of about 5000 to 10,000 Angstroms (see the paragraph bridging cols. 10 and 11). It is the Examiner's position that components of the solar energy that are ineffective to evoke cell electrical output are removed, as per instant step (c) in said claim 1, and corrected light is produced, particularly in view of House et al's teaching that silicon does not respond to wavelengths greater than about 10,000 Angstroms (see col. 8, lines 20-26). Furthermore, said lens (28) directs the corrected light to the cell edge illumination surface as in instant step (d) of said claim 1 (see Figure 1; and col. 4, lines 38-45). As seen in Figure 1, there are terminals (16) at

either end of the photovoltaic cell to be connected to a load, as per step (e) in instant claim 1 (see col. 4, lines 46-61).

With respect to claims 2 and 25, the stack orientation in House et al can be at an angle less than 90°, e.g. an angle of about 70° (i.e. House et al's deviation angle of about 20° from parallel) with respect to the receiving surface (see Figures 1 and 3E; and the paragraph bridging cols. 6 and 7).

With respect to claims 3 and 26, the stack orientation in House et al can be at an angle of about 85° to about 70° (i.e. House et al's deviation angle of about 5° to about 20° from parallel) with respect to the receiving surface (see Figures 1 and 3E; and the paragraph bridging cols. 6 and 7). House et al does not specifically recite an angle generally equivalent to Brewster's angle. However, in the absence of anything unexpected, it would have been obvious to one of ordinary skill in the art at the time the invention was made to have selected an angle within House et al's range of about 70° to about 85°. It is the Examiner's position an angle generally equivalent to Brewster's angle is within said range of about 70° to about 85°.

With respect to claims 4, 6, and 21, the concentrating lens (28) is dichroic since the light is divided into two parts, i.e. the wavelengths in the range from about 5000 to about 10,000 Angstroms which are transmitted to the photovoltaic cell, and the wavelengths above about 10,000 Angstroms and below about 5000 Angstroms which are reflected (see col. 8, lines 15-26; and the paragraph bridging col. 10 and 11). The concentrating lens (28) is a mirror due to the fact that it reflects said wavelengths above about 10,000 Angstroms and below about 5000 Angstroms. The reflected wavelengths

above about 10,000 Angstroms correspond to wavelengths above the bandgap energy wavelength (e.g., of silicon) which actually has a bandgap energy wavelength of 11,000 Angstroms, i.e., 1100 nm. The wavelengths below about 5000 Angstrom correspond to wavelengths below the bandgap energy wavelength (e.g., of silicon) (see also col. 8, lines 20-22). The wavelengths above about 10,000 Angstrom are ineffective to evoke cell electrical output (see col. 8, lines 20-22).

With respect to claims 5, 10, and 28, wavelengths in the range of about 5000 to about 10,000 Angstroms are transmitted to the photovoltaic cell (see col. 8, lines 20-22; and the paragraph bridging col. 10 and 11). The about 10,000 Angstroms, i.e., about 1000 nm, corresponds to the bandgap energy wavelength of 1100 nm for silicon, particularly when House et al teaches that silicon does not respond to wavelengths above about 1000 nm (see col. 8, lines 20-22). The about 5000 Angstroms is one-half of this.

With respect to claim 7, it is the Examiner's position that House et al's lens (28) provides for the instant substantially uniform integrity of the impinging light, and homogenizes the light prior to impingement upon the receiving surface of the photovoltaic cell.

With respect to claims 46 and 47, the lens (28) can contain cyanine dye, which is luminescent (see the paragraph bridging cols. 10 and 11).

House et al is not limited to the lens concentrator in Figure 1, as evidence by claim 1 in House et al, which is drawn to the photovoltaic energy converter without any recited lens, and by House et al's teaching at col. 11, lines 60-63, that in place of or in

addition to the lens concentrator, a mirror arrangement can be used. House et al's photovoltaic converter provides the advantage of being able to be used under high intensity illumination, and the advantage of efficiently converting solar energy to electrical energy (see col. 2, lines 20-26). House et al's exemplifies the use of silicon for the semiconductor in its device, but is not limited to this material (see col. 8, lines 14-26; and col. 11, lines 50-51).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used plural of House et al's photovoltaic converters, either with or without House et al's concentrating lens, for the plural solar cells in Lewis et al's device because House et al's photovoltaic converter provides the advantage of being able to be used under high intensity illumination, and the advantage of efficiently converting solar energy to electrical energy (see col. 2, lines 20-26). With respect to claims 19 and 21, the use of House et al's photovoltaic converter structure for the silicon, germanium and gallium arsenide solar cells in Lewis et al (see page 403, left column; and Figure 3 of Lewis et al) would have been within the skill of an artisan.

21. Claims 9, 14, 15, and 32-34 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al further in view of House et al as applied to claims 1-8, 10, 18-21, 24-26, 28, 46, and 47 above, and further in view of Penn (U.S. Patent 6,469,241), Clark (U.S. Patent 4,350,837), and Winston (U.S. Patent 3,923,381).

Lewis et al further in view of House et al is relied upon for the reasons recited above. Lewis et al teaches the use of aluminum mirrors (see the right paragraph on page 405), but with respect to claims 32-34, does not specifically teach that the mirror is

a primary concentrator, nor does Lewis teach the instant non-imaging concentrator. Penn and Clark are relied upon for showing the use of a mirror as a primary concentrator for a solar cell system (see Figure 3 of Penn; and Figure 2 of Clark). In particular, Penn shows receiving mirror (30) to concentrate the light (see Figure 3 and col. 8, lines 27-29), and Clark shows concentrator, i.e., mirror (1) (see Figure 2; and col. 4, lines 28-47). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Lewis et al's aluminum mirrors as primary concentrators in Lewis et al's in view of House et al's device because mirrors are conventionally used as primary concentrators in solar cell devices, as shown by Penn and Clark, and so as to concentrate the light.

Furthermore, Winston teaches the instant non-imaging concentrator having the instant inwardly depending logarithmically defined sloping surface having an angle with respect to a centrally disposed axis, as here claimed (see Figures 3, 7, 12-14, and 16; and col. 5, line 57 through col. 8, line 33). As seen in Figure 16, the concentrator is directly above the solar energy collection device. Winston's non-imaging concentrator provides the advantage of exceptional efficiency for the collection and concentration of electromagnetic energy (see col. 2, lines 23-25). It would have been obvious to one of ordinary skill in the art at the time the invention was made to have provided Lewis et al's in view of House et al's device with the concentrator's of Winston directly above the solar cells, i.e., between the solar cells and the dichroic beam splitters because Winston teaches the use of its non-imaging concentrator directly above the energy collector, and

Winston's non-imaging concentrator provides the advantage of exceptional efficiency for the collection and concentration of electromagnetic energy.

22. Claims 16 and 38 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lewis et al further in view of House et al as applied to claims 1-8, 10, 18-21, 24-26, 28, 46, and 47 above, and further in view of Bell, U.S. Patent 4,115,149.

Lewis et al further in view of House et al, as relied upon for the reasons recited above, teaches the limitations of instant claim 38, the difference being that Lewis et al does not specifically teach, for example, the use of a spherical mirror as a coma of light distribution in place of its parabolic Fresnel lens. Bell teaches the alternative use of a Fresnel lens or a spherical mirror with natural spherical aberrations to reduce the inefficiency of a photovoltaic cell-concentrator arrangement (see abstract; col. 2, lines 26-37; and col. 4, lines 15-28). It is the Examiner's position that said natural spherical aberrations lead to the instant coma of light distribution. It would have been obvious to one of ordinary skill in the art at the time the invention was made to have used Bell's spherical mirror in place of Lewis et al's Fresnel lens in the device of Lewis et al further in view of House et al because Bell teaches the alternative use of a spherical mirror with natural spherical aberrations to provide the advantage of reducing the inefficiency of a photovoltaic cell-concentrator arrangement.

Allowable Subject Matter

23. Claims 11-13, 17, 35-37, and 39 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, 2nd paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

24. The following is a statement of reasons for the indication of allowable subject matter: Claims 11-13 and 35-37 would be allowable because while Winston does show the instant secondary concentrator with sloping internally reflecting surface, there is no motivation to make an internally reflecting surface in this concentrator a dichroic device when used in the instant method. With respect to claims 17 and 39, while etalon mirrors are known, there is no motivation to use such a mirror in the instant method.

Conclusion

25. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

U.S. Patents 3,018,313, 5,089,055, 6,015,950, and 6,057,505 are hereby made of record. Also made of record is Martf et al, 'High efficiency photovoltaic conversion with spectrum splitting on GaAs and Si Cells in light confining cavities," IEEE (1993), pages 768-773.

26. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Alan Diamond whose telephone number is 571-272-1338. The examiner can normally be reached on Monday through Friday, 5:30 a.m. to 2:00 p.m. ET.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Nam Nguyen can be reached on 571-272-1342. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Alan Diamond
Primary Examiner
Art Unit 1753

Alan Diamond
April 7, 2005